NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**B. Tech. in Electrical Engineering**
Semester:	**IV**
Course Code:	**2EE504**
Course Title:	**Control System Theory**
Course Type:	**Core**
Year of Introduction:	**2023 – 24**

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to –

1. develop mathematical model of Linear Time Invariant (LTI) System. **(BL6)**
2. comprehend behaviour of LTI system in time domain. **(BL2)**
3. apply the concept of stability and design compensator **(BL3)**
4. elaborate behaviour of LTI system in frequency domain. **(BL2)**
5. analyse state space behaviour of LTI system, controllability and observability **(BL4)**

Syllabus: **Teaching Hours: 30**

Unit-1 **Introduction to Control Systems** **06**

Open loop and closed loop systems, effects of feedback, Mathematical modeling of physical analogous system, Transfer function model of linear time invariant (LTI) system, block diagram reduction technique and introduction to signal flow graphs.

Unit-2 **Time response analysis** **05**

Standard test signals in time-domain and Laplace domain. Time response of first order system: RC and RL circuits. Time response of second order systems and their design specifications.

Unit-3 **Stability Analysis and Compensator Design** **06**

Concept of stability, Routh and Hurwitz criterion for stability assessment, Root Locus, Lag compensator, Lead Compensator, Lead-Lag Compensator.

Unit-4 **Frequency response analysis** **07**

Concept of frequency response, frequency domain design specifications, construction of Bode plot and polar plot. Nyquist criterion, Relative stability using Nyquist criterion.

Unit-5 **State variable techniques** **06**

Concept of state and state variables, state space modelling, solution of state equations, conversion between state space and transfer function model, Concept of controllability and observability, Pole placement by state feedback.

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Reading:

1. Norman S. Nise, Textbook of Control Systems Engineering Vol – I, John-Wiley, New York.
2. Benjamin C. Kuo, Textbook of Automatic Control Systems, Prentice Hall of India, New Delhi.
3. K. Ogata, Textbook of Modern Control Systems, K. Ogata, Prentice Hall of India, New Delhi.
4. I. J. Nagrath, M. Gopal, Textbook of Control System Engineering, New Age International (I) Ltd.
5. U. A. Patel, Textbook of Control Systems Engineering, Mahajan Publishing House, Ahmedabad.
6. G Franklin, J. D. Powell, Textbook of Feedback Control of Dynamic Systems, A Emami-Naeini

Some suggested list of experiments (but not limited to this):

1. Introduction to MATLAB for control system engineering.
2. To determine response of physical systems.
3. To learn commands in MATLAB to reduce linear systems block diagram using series, parallel and feedback configurations.
4. To represent linear time invariant system and determine responses using MATLAB.
5. To study the response of first and second order systems and their time response specifications using MATLAB.
6. To find steady state error and stability of LTI system using MATLAB.
7. To study root locus technique for analysis and design of LTI system using MATLAB.
8. To design PI, PD and PID controller using root locus method in MATLAB.
9. To study frequency response analysis of control system using MATLAB.
10. To obtain state space modelling of physical system using MATLAB.
11. To study conversion between transfer function and state space model and implement using MATLAB.
12. To design controller using pole placement method and implement using MATLAB.

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. academic year 2023 - 24 and onwards